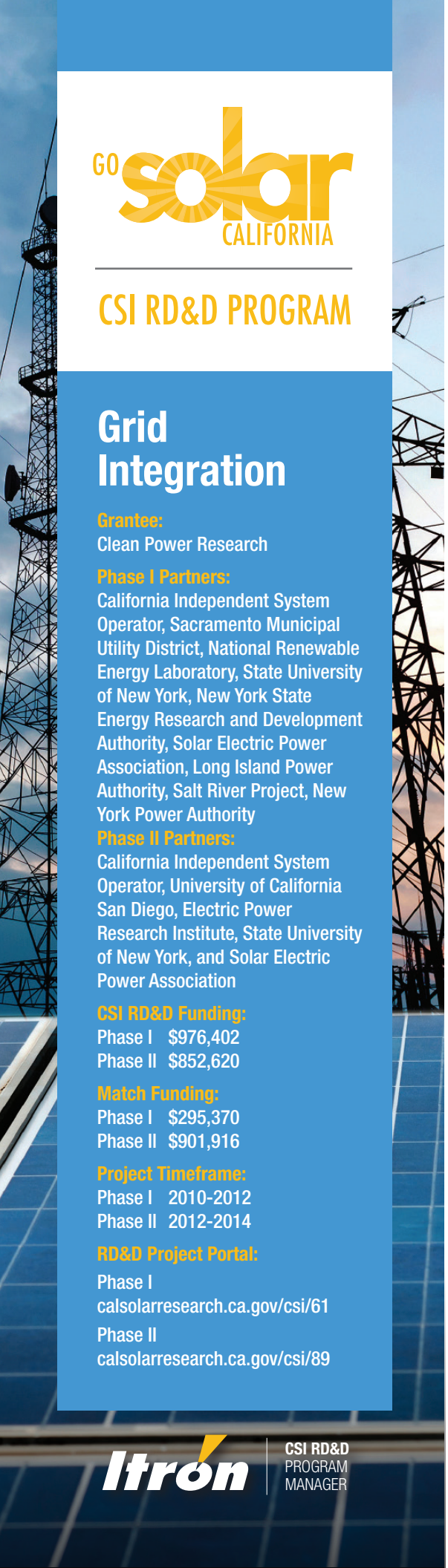


GO solar CALIFORNIA

CSI RD&D PROGRAM

Grid Integration

Grantee:
Clean Power Research

Phase I Partners:
California Independent System Operator, Sacramento Municipal Utility District, National Renewable Energy Laboratory, State University of New York, New York State Energy Research and Development Authority, Solar Electric Power Association, Long Island Power Authority, Salt River Project, New York Power Authority

Phase II Partners:
California Independent System Operator, University of California San Diego, Electric Power Research Institute, State University of New York, and Solar Electric Power Association

CSI RD&D Funding:
Phase I $976,402
Phase II $852,620

Match Funding:
Phase I $295,370
Phase II $901,916

Project Timeframe:
Phase I 2010-2012
Phase II 2012-2014

RD&D Project Portal:
Phase I
calsolarresearch.ca.gov/csi/61
Phase II
calsolarresearch.ca.gov/csi/89

Itron | CSI RD&D PROGRAM MANAGER

Advanced Modeling and Verification for High Penetration PV and Incorporation into Utility Tools

OVERVIEW AND OBJECTIVES

Utility grid operations and planning models and tools lack the ability to account for the variability of distributed PV generation resources and technologies. Insolation data used in utility models is low resolution, providing only hourly resource values. Rapidly changing weather conditions over small areas can have significant impacts on aggregate PV system output, contributing to grid operators' concerns about integrating PV into the utility grid. To address these barriers, Clean Power Research (CPR) was funded to conducted research in two phases.

Phase I: The goal was to enhance and validate the spatial and temporal resolution of solar radiation data sets for select California locations and integrate these capabilities into distribution system engineering and analysis tools. Additionally, a tool was to be created to calculate the economic value of a specific PV fleet configuration.

Phase II: Building on the Phase I work, the goal was to extend the enhanced solar resolution database and create high resolution (one-kilometer, one-minute resolution) database and benchmark data accuracy. Additionally, the PV fleet simulation methods developed in Phase I would be validated using measured ground data from PV system fleets and these methodologies would be integrated into utility software tools for distribution planning and balancing area operations.

This document provides a brief project description. For more detail on the project and the California Solar Initiative's (CSI) Research Development, Demonstration & Deployment (RD&D) Program, please visit calsolarresearch.ca.gov

The CSI RD&D Program is managed by Itron on behalf of the California Public Utilities Commission (CPUC).

PHASE I: METHODOLOGY

The CPR team obtained high resolution satellite imagery and set up a server to host the data. Irradiance measurement stations were installed in a PV system layout to model PV systems and account for variability. PV simulation software services were developed and integrated into existing distribution software and a web tool was built to analyze the economic value of the various PV fleet configurations based on a number of key factors.

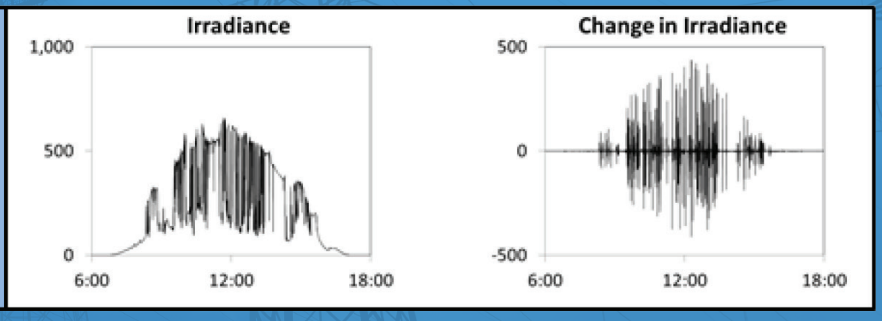
PHASE I: RESULTS AND OUTCOMES

CPR developed SolarAnywhere Enhanced Resolution (one-kilometer, 30-minute) database *ca.solaranywhere.com* for use in the forecasting and planning tools used by the California Independent System Operator (CAISO), utilities, and the research community. This data is available at no cost as part of this grant. The research team also developed an algorithm for PV output variability for various geographical locations and included it in PV modeling tools. Additionally, a tool was developed for calculating the economic value of distributed PV fleets and includes energy value, generation capacity value, environmental value, fuel price hedge value, transmission and distribution capacity value, and loss savings.

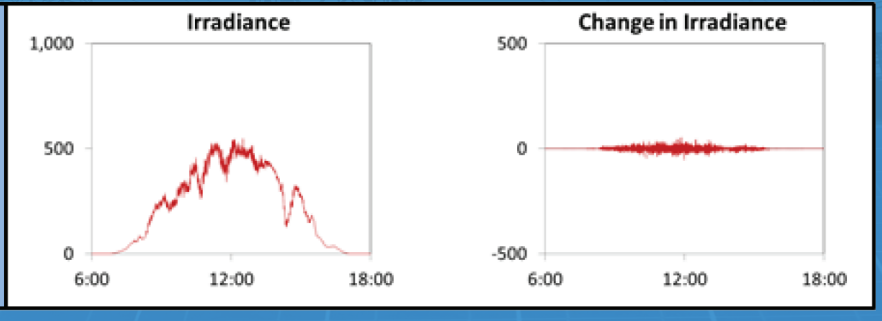
Evaluate the PV fleet, not individual PV systems: 4 km x 4 km grid in Napa, CA

Measured 10-second irradiance data from 4 km x 4 km grid in Napa on a highly variable weather day

1 LOCATION MEASURED

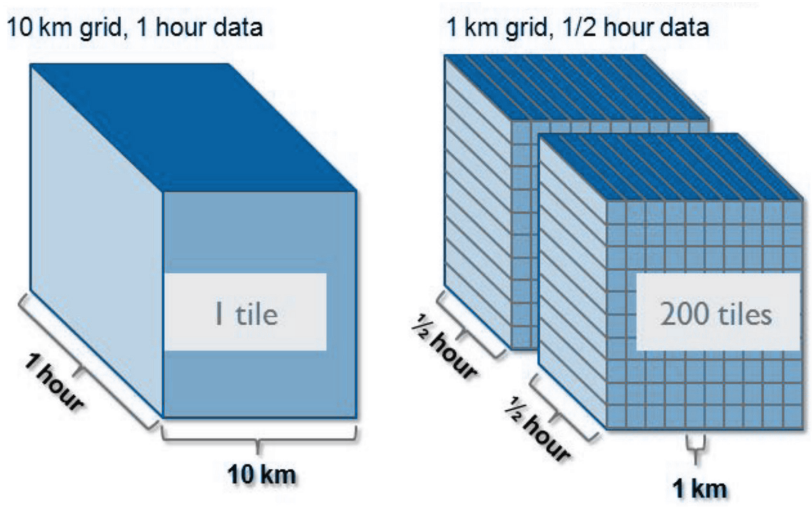


25 LOCATIONS MEASURED



PHASE II: METHODOLOGY

The SolarAnywhere Enhanced Resolution (one-kilometer, 30-minute) data was processed using the Cloud Motion Vector (CMV) approach to produce SolarAnywhere High Resolution (one-kilometer, one-minute) data. The CMV approach determines cloud movement by comparing consecutive enhanced resolution images. For validation of the PV fleet simulation, CAISO provided production data for 46 metered PV plants, and the Sacramento Municipal Utility District (SMUD) provided measured hourly production data and specifications for 2,206 distributed PV systems in their service territory. To integrate PV fleet simulation into software tools and to support CAISO's understanding of behind-the-meter PV fleet performance and production, CPR designed, tested, and implemented a PV fleet forecasting system. The fleet simulation incorporates high resolution solar resource data, PV system specifications, and a simulation model to convert this information into production.



Enhanced spatial and temporal resolution data set results in 200-fold increase in data.

PHASE II: RESULTS AND OUTCOMES

The CPR team developed, validated, and integrated PV fleet simulation tools that enable utilities and CAISO to cost-effectively integrate distributed PV resources into their planning, scheduling, and operating strategies. The research resulted in SolarAnywhere High Resolution (one-kilometer, one-minute) database. This database was used to validate previously developed PV fleet simulation methods using ground data from PV fleets connected to California's electricity grid. The validated fleet methodologies along with the high resolution solar resource database were integrated into utility software tools used for distribution planning and CAISO balancing area operations. CPR generated high resolution forecasts every 30 minutes for the entire state.

PUBLIC BENEFITS

SolarAnywhere High Resolution (one-kilometer, one-minute) database is state-of-the-art and provides the highest known resolution of any satellite-based irradiance dataset in the world, freely available at www.SolarAnywhere.com. This database is being used in PV penetration studies, variability studies, solar forecasting for the CAISO, and by project developers to obtain lower financing rates due to lower project risks.

The validated PV fleet simulation models using real-world data provide grid operators with confidence in the models prior to their use.

Prior to this research, CAISO did not have visibility into the performance of behind-the-meter PV systems and was concerned with the effect of power production from customer-owned PV on the balancing area. CPR began providing behind-the-meter PV fleet forecasts every 30 minutes to CAISO, giving them visibility into behind-the-meter PV performance. This has the additional benefit of being a valuable case study for California's IOUs as they consider using the same approach for their needs.

The tools and data streams developed through these two research projects are made available to utilities, ISOs, and others to help cost-effectively and reliably integrate distributed PV into the grid, supporting the transformation of the electric power grid into a clean energy marketplace.